

REMARKS/ARGUMENTS

Claims 1-30 were pending of which Claims 1-8 and 18-30 were rejected and Claims 9 and 10 were objected to. Claims 1, 9, 18-21 and 23 have been amended and Claims 8, 25 and 27 have been cancelled.

The Examiner objected to Claims 9 and 10 as being dependent upon a rejected base claim, but indicated that they would be allowable if rewritten in independent form including all the limitations of the base claim and any intervening claims. Claim 9 has been so amended. Claim 10 depends from Claim 9. Thus, the scope of Claims 9 and 10 has not been narrowed. No new matter has been added in the claims.

Claims 11-17 were allowed.

Claim Rejections – 35 U.S.C. §102

Claims 1, 2, 4, 23 and 30

Claims 1, 2, 4, 23 and 30 were rejected under 35 U.S.C. §102(e) as being anticipated by Wada et al.

The Examiner specifically referenced col. 90, lines 53-60, of Wada et al. This is a portion of the description of "Example 34" of Wada et al., which is pictorially described in Figs. 39A-39C (col. 35, lines 30-32). Example 34 entails the deposition of an Al wiring layer 1, an interlayer insulating film 3, an Si film 7, an Al film 8, and "a film 9 containing Ti or a TiHx compound impregnated with a sufficient amount of hydrogen" (col. 90, lines 60-62).

Claim 1 has been amended to recite "depositing an aluminum layer over the titanium layer." In the portion of Wada et al. cited by the Examiner an aluminum layer 8 is deposited *under* a film containing Ti or a TiHx compound impregnated with hydrogen. Thus, at least for this reason, Claim 1 is allowable over Wada et al. Claims 2 and 4 depend from Claim 1 and are therefore also allowable over Wada et al.

Claim 23 has been amended to recite "depositing a titanium nitride layer on said titanium layer" and "depositing an aluminum layer on said titanium nitride layer." In the cited portion of Wada et al. there is no reference to a titanium nitride layer and, as described above, the Ti or TiHx layer is deposited *over* the aluminum layer. Thus, Claim

23 is allowable over Wada et al. Claim 30 depends from Claim 23 and is therefore also allowable.

Claims 1, 2, 23 and 30

Claims 1, 2, 23 and 30 were rejected under 35 U.S.C §102(b) as being anticipated by Takayama.

The Examiner specifically referenced col. 2, lines 16-34, of Takayama. Takayama describes "an alloy film essentially comprising iron and at least one element selected from the group including Nb, Zr, Ta, Hf, Ti, V, and Si" which is "prepared by sputtering, chemical vapor deposition (CVD) or other suitable means in a gas atmosphere including hydrogen or oxygen" (col. 2, lines 16-20). There is no mention of depositing an aluminum layer over a titanium layer or a titanium nitride layer. Therefore, Claims 1 and 23 are allowable over Takayama for the reasons expressed above in connection with Wada et al. Claims 2 and 30 are allowable by reason of their dependency on Claims 1 and 23, respectively.

Claims 1, 2, 4, 23 and 30

Claims 1, 2, 4, 23 and 30 were rejected under 35 U.S.C. §102(b) as being anticipated by Teng et al.

The Examiner specifically referenced col. 2, lines 35-48, of Teng et al.

Teng et al. relates to "the unique formation of hydrogen modified, titanium micro-texturing where titanium is sputter deposited on a thin film magnetic media disk substrate in the presence of hydrogen . . . to form micro-texturing bumps or nodules" (col. 1, lines 12-19). The portion cited by the Examiner recites "sputter depositing titanium from the titanium target in the presence of the hydrogen to form hydrogen-treated titanium nodules (i.e., bump-like configurations) on the substrate" (col. 2, lines 45-48). There is no mention of depositing an aluminum layer over a titanium layer or a titanium nitride layer. Therefore, Claims 1 and 23 are allowable over Teng et al. for the reasons expressed above in connection with Wada et al. Claims 2 and 4 and Claim 30 are allowable by reason of their dependency on Claims 1 and 23, respectively.

Claim Rejections – 35 U.S.C. §103

Claim 29

Claim 29 was rejected under 35 U.S.C. §103(a) as being unpatentable over Wada et al. Claim 29 depends from Claim 23, which recites "depositing a titanium nitride layer on said titanium layer" and "depositing an aluminum layer on said titanium nitride layer". As described above, Claim 23 is allowable over Wada et al. because in Wada et al. the aluminum layer is deposited *under* the Ti or TiHx layer. There is no suggestion in Wada et al. that the Al layer could be deposited *over* the Ti or TiHx layer. The process taught by Wada et al. is carried out by "allowing the Si film to be substituted by the Al film, and at the same time allowing the Si film to reach the Ti or TiHx film impregnated with hydrogen thereby to form a Ti silicide" (col. 91, lines 1-4). The Ti or TiHx film thus becomes a Ti silicide. In contrast, in the process claimed by Applicants a titanium layer is sputter-deposited in the presence of hydrogen to provide an *overlying* aluminum layer with a preferred crystal orientation. The process of Wada et al. and the process of the Applicants are therefore very different. A person of skill in the art, upon reading Wada et al. would have not motivation or incentive to carry out the process claimed by the Applicants in order to provide a titanium layer having a <0002> crystal orientation.

Claims 3, 18, 20, 21, and 24

Claims 3, 18, 20, 21, and 24 were rejected under 35 U.S.C. §103(a) as being unpatentable over Wada et al. in view of Yamadai.

The Examiner stated:

"Yamadai discloses a method of forming a layer on a substrate where a titanium layer (3), with a <002> orientation, is sputter deposited on a substrate (1), then a titanium nitride layer (4), with a preferred <111> orientation, is formed on the titanium layer (3) and an aluminum layer (5), with a <111> orientation, is formed on the titanium nitride layer (4) (col. 3, line 17 thru col. 5, line 41, col. 5, lines 1-33)."

The following passage of Yamadai describes the process by which the titanium film 3 is deposited (col. 4, lines 15-20):

"Then, a Ti film 3 is formed to a thickness of about 500 to 1,500 Å on the layer insulating film by a usual DC magnetron reactive sputtering method under the conditions of a pressure of 2 to 5 mTorr, a DC power of 1 to 3 kW and a flow rate of argon of 80 to 100 sccm."

Thus Yamadai makes no reference to the use of a hydrogen-containing atmosphere and in fact states specifically that the "usual" process is used to form the titanium film.

Wada et al. contains no reference to the crystal orientation of the titanium film 9. Moreover, since the Ti or TiHx film 9 of Wada et al. is deposited *after* the aluminum film 8 (see Fig. 39A) it is apparent that the crystal orientation of Ti or TiHx film 9 could not determine the crystal orientation of aluminum film 8.

In short, Wada et al. teaches sputter-depositing a titanium layer in an atmosphere comprising hydrogen, but Wada et al. does not teach that doing so provides a preferred crystal orientation in the titanium layer or in an overlying aluminum layer. Yamadai teaches a stack including a titanium layer having a <002> crystal orientation, a titanium nitride layer having a <002> crystal orientation, and an aluminum alloy film having a <111> crystal orientation, but Yamadai does not teach that the titanium layer should be deposited in an atmosphere comprising hydrogen in order to achieve the <002> crystal orientation.

Thus a person of skill in the art would obtain no suggestion by reading Yamadai and Wada et al. together that "depositing a titanium layer onto the substrate by physical vapor deposition of the source of titanium under conditions wherein the atmosphere in the deposition chamber comprises hydrogen" and then "depositing an aluminum layer over the titanium layer," as recited in Claim 1, as amended, would yield an aluminum layer having a preferred <111> crystal orientation. Claim 1 is therefore allowable over the combination of Wada et al. and Yamadai, as are Claims 3 and 18 (as amended), both of which depend from Claim 1.

Claim 20 has been amended to recite "depositing a titanium layer the titanium layer deposition comprising . . . flowing a first gas comprising hydrogen into the sputtering chamber through a first gas injector" and "sputter depositing an aluminum layer over the titanium layer." Thus, for similar reasons, Claim 20 is allowable over the combination of Wada et al. and Yamadai. Claim 21 depends from Claim 20 and is therefore also allowable over Wada et al. in view of Yamadai."

Claim 23 has been amended to recite "depositing a titanium nitride layer on said titanium layer" and "depositing an aluminum layer on said titanium nitride layer." Thus, for similar reasons, Claim 23 is allowable over the combination of Wada et al. and Yamadai.

Claim 24 depends from Claim 20 and is therefore also allowable over Wada et al. in view of Yamadai."

Claims 5 and 8

Claims 5 and 8 were rejected under 35 U.S.C. §103(a) as being unpatentable over Wada et al. in view of Yamadai and further in view of Freeman et al. The Examiner cited Freeman et al. as disclosing "the gas mixgture comprising at least 4 mole percent hydrogen (col. 4, lines 7-57)."

Claim 5 depends from Claim 1. As described above, Claim 1 is allowable over the combination of Wada et al. and Yamadai. Freeman et al. teaches nothing that changes this conclusion with respect to Claim 1. Freeman et al. teaches the deposition of a CoPt magnetic film in a sputter chamber that includes hydrogen (col. 4, lines 37-41). Contrary to the statement at page 6, lines 14-15, of the Office Action, Freeman et al. does not teach the deposition of a titanium layer. Hence, Claims 1 and 5 are allowable over the combination of Wada et al., Yamadai and Freeman et al.

Claim 8 has been canceled.

Claims 6 and 7

Claims 6 and 7 were rejected under 35 U.S.C. §103(a) as being unpatentable over Wada et al. in view of Kaloyeros et al. The Examiner cited Kaloyeros et al. as disclosing "the power used in the sputtering method having a power density of between 0.01 W/cm² and 10 W/cm² (col. 10, lines 60-67; col. 11, lines 1-17)."

Claims 6 and 7 depend from Claim 1. As described above, Claim 1 is allowable over Wada et al. Kaloyeros et al. teaches nothing that changes this conclusion with respect to Claim 1. Kaloyaeros et al. is concerned with the chemical vapor deposition of a film comprising tantalum (col. 4, lines 51-52). Hence, Claims 1, 6 and 7 are allowable over the combination of Wada et al. and Kaloyeros et al.

Claims 19 and 22

Claims 19 and 22 were rejected under 35 U.S.C. §103(a) as being unpatentable over Wada et al. in view of Yamadai and further in view of Hsu et al. The Examiner cited Hsu et al. as disclosing "the aluminum layer having a FWHM of 1.5 degrees (col. 3, lines 11-65)."

Claim 19 depends from Claim 1. Claim 22 depends from Claim 20. As described above Claim 1 is allowable over Wada et al. and Claim 20 is allowable over Wada et al. in view of Yamadai.

The addition of Hsu et al. to Wada et al. does not change this conclusion as regards Claim 1. Hsu et al. teaches the possible use of a nitrogen/hydrogen plasma to remove certain residual contaminants, such as sulfur and fluorine, from a titanium nitride surface (col. 2, lines 39-43; col. 4, lines 26-30). Hsu et al. does not teach or suggest "depositing a titanium layer onto the substrate by physical vapor deposition of the source of titanium under conditions wherein the atmosphere in the deposition chamber comprises hydrogen," as recited in amended Claim 1. Therefore Claim 19, which depends from Claim 1, is also allowable over the combination of Wada et al. and Hsu et al.

For the same reasons, the addition of Hsu et al. to Wada et al. and Yamadai does not change this conclusion as regards Claim 20, which recites "flowing a first gas comprising hydrogen into the sputtering chamber through a first gas injector" and "sputter depositing the titanium layer onto the substrate by applying power to the titanium target." Therefore Claim 22, which depends from Claim 20, is also allowable over the combination of Wada et al., Yamadai and Hsu et al.

Claims 25-28

Claims 25-28 were rejected under 35 U.S.C. §103(a) as being unpatentable over Wada et al. in view of Kitch et al. The Examiner cited Kitch as disclosing "forming a titanium layer on a substrate where a substrate (12) is placed in a deposition chamber comprising a source of titanium, depositing the titanium layer (13) onto the substrate in an atmosphere that comprises argon, then forming an aluminum layer (16) on the titanium layer (13)" and as further disclosing "forming a titanium nitride layer (15) over the titanium layer (13) (col. 5, lines 6-30)."

Claims 26 and 28 depend from Claim 23. As described above, Claim 23 is allowable over Wada et al.

The addition of Kitch et al. to Wada et al. does not change this conclusion. Claim 23 has been amended to recite "depositing a titanium nitride layer on said titanium layer" and "depositing an aluminum layer on said titanium nitride layer." In Wada et al., as described above, the Ti or TiH_x layer is deposited over the aluminum layer. In contrast,

Kitch et al. teaches "a titanium (Ti) layer 13 and a titanium nitride (TiN) layer 15 disposed on the Ti layer 13" (col. 5, lines 10-12). An aluminum layer 16 overlies TiN layer 15 (col. 4, line 64). A person of skill in the art would not be motivated to apply the process technique for forming the TiHx layer taught by Wada et al. (i.e., sputtering a Ti target in a gaseous atmosphere comprising hydrogen) to the process described in Kitch et al. because the structures involved are different and as a result there would be no apparent purpose in doing so. Neither Wada et al. nor Kitch et al. teaches that sputter-depositing a titanium layer in a hydrogen-containing atmosphere produces a titanium layer having a preferred <0002> crystal orientation.


Since Claim 23 is allowable over the combination of Wada et al. and Kitch et al., Claims 26 and 28 are also allowable over Wada et al. in view of Kitch et al.

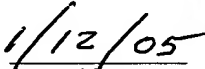
Claims 25 and 27 have been canceled.

For the above reasons, Applicants respectfully request allowance of Claims 1-7, 9-24, 26 and 28-30. Should the Examiner have any questions concerning this response, the Examiner is invited to call the undersigned at (408) 982-8200, ext. 1.


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Attorney for Applicant(s)


Date of Signature

Respectfully submitted,


David E. Steuber
Attorney for Applicant(s)
Reg. No. 25,557

SILICON VALLEY
PATENT GROUP LLP

50 Mission College Blvd
Suite 360
Santa Clara, CA 95054
(408) 982-8200
FAX (408) 982-8210